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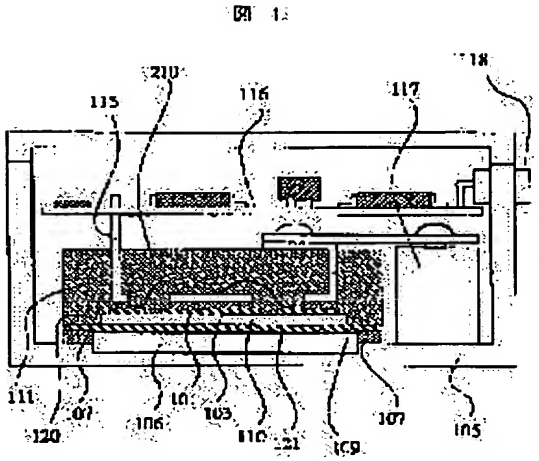
(54) INVERTER DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a small-sized, efficient inverter device by adopting a connecting structure where watertightness is ensured and further there is no risk of cracking in an insulation board, to reduce the thermal resistance between a power element and coolant.
SOLUTION: In the inverter device, the rear-face electrode plate of the insulation board is larger in size than the insulating board, the peripheral portion of the rear-face electrode plate is jointed with a case, and the flow path of the coolant is formed directly under the insulating board. Furthermore, the front-face electrode plate of the insulating board is constituted, so that the thickness thereof is not less than 0.5 mm or constituted of a heat pipe, and the rear-face electrode is provided with projections and recesses, having a pitch of not more than 3 mm. The rear-face electrode plate and the case are jointed to each other through soldering, adhesive, a mechanical means, or a combination thereof.



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CLAIMS

[Claim(s)]
[Claim 1] In the inverter equipment which consists of the power circuit section which consists of a power component, an insulating substrate, a terminal in which the electrode plate was joined to the front flesh side, and said power component was carried, etc., a case where the passage of a cooling refrigerant was formed, and a control circuit part The rear face of the insulating substrate to which the electrode plate by the side of the cooling refrigerant of the insulating substrate to which said electrode plate was joined was larger than the insulating substrate, the periphery of the electrode plate by the side of said cooling refrigerant was joined to the case, and the electrode plate was joined is inverter equipment characterized by being cooled with the cooling refrigerant.
[Claim 2] The electrode plate by the side of the power component of the insulating substrate to which the electrode plate was joined is 0.5mm. Inverter equipment according to claim 1 characterized by being the above thickness.
[Claim 3] The electrode plate by the side of the cooling refrigerant of the insulating substrate to which the electrode plate was joined is inverter equipment according to claim 1 characterized by preparing irregularity with a pitch of 3mm or less.
[Claim 4] The electrode plate by the side of the power component of the insulating substrate to which the electrode plate was joined is inverter equipment according to claim 1 characterized by consisting of heat pipes.
[Claim 5] Junction of the case where the passage of the cooling refrigerant lateral electrode plate periphery of an insulating substrate and cooling refrigerant to which the electrode plate was joined was formed is inverter equipment according to claim 1 characterized by considering as solder, adhesives, mechanical immobilization, or such junction structures that were compounded.
[Claim 6] The electrode plate by the side of the cooling refrigerant of the insulating substrate to which the electrode plate was joined is inverter equipment according to claim 1 characterized by joining a front-face side to a case and being joined to other case members from which a rear-face side constitutes the passage of a cooling refrigerant.
[Claim 7] In the inverter equipment which consists of the power circuit section which consists of a power component, an insulating substrate, a terminal in which the electrode plate was joined to the front flesh side, and said power component was carried, etc., a case where the passage of a cooling refrigerant was formed, and a control circuit part It is inverter equipment which the electrode plate by the side of the cooling refrigerant of the insulating substrate to which said electrode plate was joined is larger than an insulating substrate, and, as for the electrode plate by the side of said cooling refrigerant, the whole surface is joined to a case part, and is characterized by cooling said case part with the cooling refrigerant.
[Claim 8] In the inverter equipment which consists of the power circuit section which consists of a power component, an insulating substrate, a terminal in which the electrode plate was joined to the front flesh side, and said power component was carried, etc., a case where the passage of a cooling refrigerant was formed, and a control circuit part The electrode plate by the side of said cooling refrigerant is inverter equipment characterized by the case part which the electrode plate by the side of the cooling refrigerant of the insulating substrate to which said electrode plate was joined is larger than an insulating substrate, the whole surface is joined to a case part, and said insulating substrate joins at least consisting of a heat pipe.
[Claim 9] In the inverter equipment which consists of the power circuit section which consists of

a power component, an insulating substrate, a terminal in which the electrode plate was joined to the front flesh side, and said power component was carried, etc., a case where the passage of a cooling refrigerant was formed, and a control circuit part The electrode plate by the side of the cooling refrigerant of the insulating substrate to which said electrode plate was joined is larger than an insulating substrate, and the closure of a power component is transfer mold structure. A power component, Inverter equipment according to claim 1 to 8 characterized by connecting the electrode terminal which is united with the external terminal with the wire or the connection plate.

[Claim 10] It sets to the ceramic insulating substrate to which the metal plate was joined by both sides, and some surface metal plates are 0.5mm at least. It is the ceramic insulating substrate which has the above thickness and is characterized by joining the rear-face metal plate to the ceramic insulating substrate in an area larger than said ceramic insulating substrate.

[Claim 11] The ceramic insulating substrate characterized by preparing irregularity in the rear-face metal plate over the whole outline surface in the ceramic insulating substrate to which the metal plate was joined by both sides.

[Claim 12] It is the ceramic insulating substrate characterized by some metal plates of at least one side consisting of a tabular heat pipe in the ceramic insulating substrate to which the metal plate was joined by both sides.

[Claim 13] It is the ceramic insulating substrate characterized by some surface metal plates being united with the leadframe in the ceramic insulating substrate to which the metal plate was joined by both sides, and joining a part of leadframe to said ceramic insulating substrate at least.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the inverter structure of realizing **** and cooling of an especially efficient power component at inverter structure.
[0002]
[Description of the Prior Art] In order to energize to a power semiconductor device in order to realize miniaturization of an inverter, and efficient-ization, and to secure stable actuation, it is required to prepare a cooler style. That is, in the inverter equipment which consists of power semiconductor devices, such as IGBT and Power MOS, in order to secure operational stability of a component, it has cooler styles, such as air cooling thru/or liquid cooling using a refrigerant, or vapor cooling, so that the temperature at the time of actuation of a semiconductor device may not exceed a predetermined marginal operating temperature. In recent years, the current density of a component is increasing from the demand to the miniaturization of inverter equipment, and efficient-izing, and since the exoergic consistency of a component has been increasing in connection with this, in order to suppress the temperature rise of a component, efficient-ization of a cooler style has been called for. In the inverter equipment especially applied to electric drive systems for automobiles, such as a hybrid electric vehicle (HEV) and a fuel cell vehicle (FCEV), a demand in small and efficient cooling structure is high because of a limit of installation area or weight.
[0003] The cooling structure shown in drawing 11 is indicated by JP,6-303704,A. In drawing 11 , the power semi-conductor module 1510 with which it is joined with solder etc. on the insulating substrate 1502, and the power semiconductor devices 1501, such as IGBT, were further joined by solder to the base metal plate 1503 is attached in the cooling section 1505 through thermally conductive grease 1504. an insulating substrate -- ceramic substrates, such as alumimium nitride (AIN) and an alumina (aluminum 2O3), -- an electrode -- public funds -- group sheet metal is joined. A capacitor 1508 and control circuit substrate 1507 grade are connected to such a power circuit section module 1510, it is carried in the case 1509 where the cooling section 1505 and one are made, and inverter equipment is constituted. The passage of cooling water 1506 is formed in the cooling section 1505. It circulates through cooling water with the external radiator using the pump of the circulating water cold system. After heat-conducting to an insulating substrate 1502, the base metal plate 1503, the cooling section 1505, etc., heat-conducting to cooling water 1506 on the heat transfer front face of passage and cooling water's moving to an external radiator with a pump, the cooling water and the open air which carried out the temperature rise carry out heat exchange of the heat generated in the power semiconductor device 1501, and it is discharged outside.
[0004] Moreover, the structure which cools an insulating-substrate rear face directly to JP,9-121557,A shown in drawing 12 is indicated. In this structure, the power semiconductor devices 1601, such as IGBT, are joined with solder etc. on the insulating substrate 1602, and the part into which the insulating substrate 1602 extended is attached in the case 1609 with the closure member 1611 with the means 1612 with a bundle, such as a bolt. an insulating substrate -- the ceramic substrates 1610, such as alumimium nitride (AIN) and an alumina (aluminum 2O3), -- an electrode -- public funds -- group sheet metal 1603 and 1604 joins. The rear face of an insulating substrate 1602 is cooled by the cooling water 1606 passing through the passage established in the case 1609.

[0005]
[Problem(s) to be Solved by the Invention] With the structure of said drawing 11 , since many layers intervene between the power semiconductor device 1501 which is the exoergic section, and cooling water 1506, sufficient refrigeration capacity is not obtained, but there is a limitation in increasing the current density of a component and miniaturizing. Moreover, with the structure of said drawing 12 , in order to attach a large-sized insulating substrate and to bind tight with a bolt, it is easy to produce the crack of an insulating substrate, and installation occupancy area also has a large problem.
[0006] The purpose of this invention is offering the structure of reducing the thermal resistance between a power component and a refrigerant by the small and simple approach, in order to realize small efficient inverter structure which can control the temperature rise of a semiconductor device effectively, even if it increases current density and miniaturizes an inverter. Moreover, the purpose of this invention is offering the structure of reducing thermal resistance with connection structure without fear, such as a crack of an insulating substrate, securing waterproofness, miniaturizing the insulating substrate of a power component and offering the easy structure of an assembly.
[0007]
[Means for Solving the Problem] The electrode plate by the side of the cooling refrigerant of an insulating substrate of the inverter equipment of this invention is larger than an insulating substrate, the electrode plate circumference by the side of a cooling refrigerant is joined to a case, the passage of a cooling refrigerant is prepared directly under an insulating substrate, and the electrode plate by the side of the power component of an insulating substrate is 0.5mm. It is the above thickness and the electrode plate by the side of the cooling refrigerant of an insulating substrate prepared irregularity with a pitch of 3mm or less.
[0008] As for the inverter equipment of this invention, the electrode plate by the side of the power component of an insulating substrate consists of heat pipes, the electrode plate by the side of the cooling refrigerant of an insulating substrate is larger than an insulating substrate, the whole surface is joined to a case part, and said case part is cooled with the cooling refrigerant. The inverter equipment of this invention is the structure where the case part which an insulating substrate joins completely consists of a heat pipe.
[0009] The electrode plate by the side of the cooling refrigerant of an insulating substrate of the inverter equipment of this invention is larger than an insulating substrate, and junction of the periphery of the case where the passage of an insulating substrate and a cooling refrigerant was formed is solder, adhesives, mechanical immobilization, or such junction structures that were compounded.
[0010] The electrode plate by the side of the cooling refrigerant of an insulating substrate of the inverter equipment of this invention is larger than an insulating substrate. An insulating substrate and the electrode plate of the joint of a case periphery with which the passage of a cooling refrigerant was formed are the bent structures. The front-face side of the electrode plate by the side of a cooling refrigerant is joined to a case, and it is joined to other case members from which a rear-face side constitutes the passage of a cooling refrigerant, and the closure of a power component is transfer mold structure, and the rear-face electrode plate of an insulating substrate is in contact with the cooling refrigerant.
[0011] With the inverter equipment of this invention, by having prepared the passage of a cooling refrigerant directly under the insulating substrate, since it becomes only an insulating substrate and a thin electrode metal plate between the power semiconductor device which is the exoergic section, and a cooling refrigerant, thermal resistance is reduced sharply. Moreover, since the electrode plate by the side of the cooling refrigerant of an insulating substrate is larger than an insulating substrate, the inverter equipment of this invention is assembled, or it can prevent the crack and crack by real use. Since there is no insulating substrate in a joint with a case especially, a junction activity is easy.
[0012] Since the electrode plate thickness by the side of the power component of an insulating substrate is 0.5mm or more, the heat of the power semiconductor device of the exoergic section can be effectively extended in a longitudinal direction, a heating area spreads, and thermal resistance reduces the inverter equipment of this invention. Moreover, since the electrode plate by the side of the cooling refrigerant of an insulating substrate has irregularity with a pitch of 3mm or less, it becomes easy to produce a turbulent flow in a cooling refrigerant, and thermal

resistance decreases.

[0013] Since the electrode plate by the side of the power component of an insulating substrate is a heat pipe, the heat of the power semiconductor device of the exoergic section can be effectively extended in a longitudinal direction, a heating area spreads, and thermal resistance reduces the inverter equipment of this invention. Moreover, since the electrode plate by the side of the cooling refrigerant of an insulating substrate is larger than an insulating substrate, the whole surface is joined to a case part and said case part is cooled with the cooling refrigerant, thermal resistance decreases, securing waterproofness.

[0014] Since the case part which an insulating substrate joins completely consists of a heat pipe, thermal resistance reduces it further, the inverter equipment of this invention securing waterproofness. Moreover, the electrode plate by the side of the cooling refrigerant of an insulating substrate is larger than an insulating substrate, and since junction of the case where the passage of the rear-face electrode plate periphery of an insulating substrate and a cooling refrigerant was formed is solder, adhesives, mechanical immobilization, or such junction structures that were compounded, it is possible. [of the junction which secured waterproofness in a small area]

[0015]

[Embodiment of the Invention] The example of this invention is explained using a drawing below. (Example 1) The sectional view of the inverter equipment of this example is shown in drawing 1 . As shown in drawing 1 , the power semiconductor devices 101, such as IGBT, have joined with solder etc. on the insulating electrode substrate 120. the insulating electrode substrate 120 -- for example, the ceramic insulating substrates 110, such as alumimium nitride (AlN), and an alumina (aluminum 2O3) or silicon nitride (SiN), -- an electrode -- public funds -- group sheet metal is joined. The thin film metal plate 103 for electrodes is joined to insulating electrode substrate 120 front face, and the thin film metal plate 121 is joined to the rear face. The emitter thru/or gate electrode of power semiconductor device 101 front face is connected to the thin film metal plate 103 with the aluminum wire 210. After, as for the part by the side of these components, the connection terminal 109,115 is joined, the power semiconductor device 101 neighborhood is closed by silicone gel as a resin ingredient 111, and the surroundings of it consist of case material made of resin, such as PPS or PBT. Or the resin ingredient 111 is transfer mold structure. In addition, although the number of power semiconductor devices is one on account of explanation in drawing 1 , more than one are usually arranged. It connects with the motor which is a main terminal, is connected to a capacitor 117 or a load and is outside, and the connection terminal 115 is a control terminal, and is connected to the control circuit substrate 116, and the connection terminal 109 inputs an external signal from a connector 118, and performs inverter actuation. The whole inverter equipment is contained in the case 105, and constitutes the inverter circuit shown in drawing 13 . In addition, in drawing 13 , component parts, such as a control circuit and a current sensor, are omitted.

[0016] Drawing 2 is the flat-surface layout pattern of the insulating electrode substrate 120 of this example, and a power component. In the circuitry of drawing 13 , it is equivalent to the plane 1 part power circuit 301, and the terminal strapping section 191 which IGBT101,302 and the free wheel diode component 195,303 are parts for one arm each in one piece as a power component, for example, is connected to the P side wiring 304, the terminal strapping section 193 connected to the N side wiring 305, the terminal strapping section 192 connected to the load wiring 306 which the motor has connected are arranged.

[0017] In this example, it is joined to the case 105 of inverter equipment where the insulating electrode substrate 120 consists of aluminum dies casting etc. by solder, adhesives, mechanical immobilization, or such junction structures that were compounded, and it is the structure which has the refrigerant 106 for cooling in insulating electrode substrate 120 rear face, and the rear-face thin film metal plate 121 is larger than an insulating substrate 110, and only the rear-face thin film metal plate 121 circumference is connected with the aluminum dies casting case 105 using the connection member 107.

[0018] As for the aluminum dies casting case 105 and the insulating electrode substrate 120, the rear-face thin film metal plate 121 circumference is connected. For example, a 3 - 14%Si content aluminum alloy or a Zn content aluminum alloy is applicable to aluminum dies casting. The eutectic solder of a low-melt point point or Pb free solder of Bi system is applicable to the solder of the connection member 107. Since high thermal conductivity is not needed for the

solder of this part, it is 0.2mm about solder thickness. It carries out above and the thermal stress to solder is mitigated. Moreover, since the aluminum dies casting case 105 is electrically connected with the rear-face thin film metal plate 121 by using solder as joint material, electromagnetic shielding nature improves.

[0019] Moreover, when the connection members 107 are adhesives, epoxy resin adhesive, polyurethane adhesive, and silicone rubber system adhesives can be applied. There is 2 acidity-or-alkalinity adhesives (for example, Yokohama Rubber Make) which contain for example, an urethane modified epoxy resin as epoxy resin adhesive, or 1 acidity-or-alkalinity adhesives (for example, Ube Industries, Ltd. make) which has oil face-bonding nature, and there are for example, 1 component-type elastic adhesives (for example, product made from a seeker) as polyurethane adhesive. When the connection members 107 are adhesives, since a hot process like [in the case of being solder connection] is not needed, manufacture is easy.

[0020] A refrigerant 106 is the antifreezing solution, water, an oil, a chlorofluorocarbon-replacing material, or air, and is flowing passage by the rate of flow set up suitably. In the case of the antifreezing solution, for example, the ethylene glycol system antifreezing solution (a trade name LLC, Denso make) is applicable. In order that the front face of the rear-face thin film metal plate 121 may prevent the corrosion by the refrigerant, processing of nickel plating of NiP, NiB, etc. is performed. The front face of the aluminum dies casting of passage gives for example, nickel chrome plating, and makes it moreover, more desirable for corrosion resistance to improve. Since it circulates through a refrigerant 106 with the pump formed separately and circulates again into the back inverter part cooled with the radiator, temperature is maintained below at constant value.

[0021] In this example, since there is only solder which joins a power component to the insulating electrode substrate 120 between the power semiconductor devices 101 and refrigerants 106 which generate heat at the time of inverter actuation, thermal resistance is very small. Therefore, since the maximum operating temperature is not exceeded and it can operate to stability even if it increases the current density of the power semiconductor device 101 and an exoergic consistency increases, a power component can be miniaturized and inverter equipment becomes small.

[0022] Moreover, in this example, since a connection is connection of metals, it is easy to make connection between the rear-face thin film metal plate 121 and the aluminum dies casting case 105, and workability improves, and it is easy to secure waterproofness. Moreover, an insulating substrate 110 is comparatively small, and since there is no connection member 107 in the lower part of an insulating substrate 110, it assembles, or the crack and crack of an insulating substrate 110 by real use can be prevented. Moreover, since [whose heat which the power semiconductor device 101 generates is the surface thin film metal plate 103, an insulating substrate 110, and the rear-face thin film metal plate 121] it is transmitted to a refrigerant 106 on rear-face thin film metal plate 121 front face, spreading a grade, the temperature rise of the aluminum dies casting case 105 which forms the passage of a refrigerant 106 is not so big. Therefore, the thermal stress which joins the connection member 107 is reduced.

[0023] (Example 2) The power circuit part of the inverter of this example is shown in drawing 3 (a). For the surface thin film metal plate 161 of an insulating electrode substrate, although it consists of composite material, such as Cu, aluminum or CuMo, and CuW, or a charge of a laminated wood of Cu and W, the thickness d1 is 0.5mm. It is above and is 0.5mm desirably. It is 2mm or less above. Breadth and thermal resistance fully decrease [the heat generated in the power semiconductor device 101 by this] with the surface thin film metal plate 161. Since the pattern circumference edge of the surface thin film metal plate 161 makes thickness thin or has formed irregularity, the crack or crack of an insulating substrate at the time of a thermo cycle cannot happen easily. Moreover, although, as for an insulating substrate, AlN etc. is chosen suitably, since it excels in mechanical strength, even if the surface thin film metal plate 161 becomes thick, it is hard to happen and is desirable [especially SiN / the crack or crack of an insulating substrate]. Since the rear-face thin film metal plate 121 is also thickened corresponding to the surface thin film metal plate 161 becoming thick substantially in order to avoid the camber and crack of an insulating substrate, breadth and thermal resistance decrease [heat] in this part. In addition, drawing 3 (b) shows the structure of an insulating electrode substrate simple substance.

[0024] For drawing 3 (c), the surface thin film metal plate consists of three layers, the inside

metal plate 801, a jointing material for corrugated fibreboard 802, and the outside metal plate 803, substantially with other structures of an insulating electrode substrate simple substance, and the thickness of these sum totals is 0.5mm. It is above. In addition, although not illustrated, with well-known junction means, such as direct junction or low material, it may be joined to an insulating substrate 110 and the inside metal plate 801 may be formed as a metallized layer. Usually, the inside metal plate 801 is 0.1mm. For this reason, the stress to the insulating substrate in a pattern edge can be eased thinly the following. When it overflows and the section 804 is formed especially, the stress relaxation effectiveness is large. A jointing material for corrugated fibreboard 802 uses direct junction and low material or solder. The outside metal plate 803 is 0.4mm in order to secure sum total thickness. It carries out above. By considering as such structure, the excessive stress to an insulating substrate is eased and dependability can be secured. Drawing 3 (d) maintained stress balance with a surface thin film metal plate also about the rear-face thin film metal plate as three layers, the inside metal plate 807, a jointing material for corrugated fibreboard 805, and the outside metal plate 806, and secured dependability. In drawing 3 (d), the outside metal plate 806 is larger than an insulating substrate.

[0025] (Example 3) This example is shown in drawing 4 (a). In this example, irregularity 141 was formed in the rear-face thin film metal plate 140. The dimensions L, such as height of irregularity 141, width of face, and spacing, are 3mm or less. Such irregularity 141 is set as the configuration and array of requests, such as a projection of the shape of the shape of stripes horizontal in the flow direction of a refrigerant, or vertical, and a pin, or a repeat of a circular hole. Since a heat transfer interface product with a refrigerant increases with such irregularity, a heat transfer rate improves and thermal resistance decreases further. Moreover, if the dimension L of such irregularity is set to 1mm or less, irregularity can be easily formed by press forming of a metal plate etc. In addition, drawing 4 (b) shows the structure of an insulating electrode substrate simple substance.

[0026] (Example 4) This example is shown in drawing 5 . The surface thin film metal plate 169 is constituted from this example by the heat pipe. As a heat pipe has the path which a heat carrier moves to the interior and it is shown in drawing 5 (b), in this example, this path 146 is a direction parallel to an insulating substrate 110. Since the surface thin film metal plate 169 is a heat pipe, the heat generated in the power semiconductor device 101 moves to a longitudinal direction with the heat carrier inside a heat pipe. For this reason, thermal resistance decreases. A heat pipe may consist of the quality of the materials, such as aluminum or Cu, and a well-known meandering capillary etc. is sufficient as it. Low material may be used for junction to the heat pipe which are an insulating substrate 110 and the surface thin film metal plate 169, and the insulating electrode substrate 129 may be constituted. Or an insulating substrate 110 may be constituted from resin and a heat pipe and resin may be pasted up by approaches, such as thermocompression bonding. The resin in this case is the resin ingredient of for example, a silicone system. In this example, according to the heat transport capacity of a heat pipe, since lateral heat breadth is large, the dimension of the longitudinal direction of the surface thin film metal plate 169 is enlarged, and thermal resistance can be reduced. Furthermore, effectiveness with the same said of the configuration which uses the rear-face thin film metal plate 121 as a heat pipe is acquired.

[0027] (Example 5) This example is shown in drawing 6 (a). In this example, as for the insulating electrode substrate 120, the whole surface is joined to the aluminum dies casting case 151. Solder 152 is used for junction. The passage where a lid 153 is formed in the aluminum dies casting case 151 at the bottom, and a refrigerant 106 flows is formed. The thickness d2 of the aluminum dies casting case joint 155 joined to the insulating electrode substrate 120 is 0.5mm. It is made the following thickness and thermal resistance is reduced.

[0028] In this example, since the amount of [which leads to the passage of a refrigerant inside an inverter] joint is not, waterproofness is high. Moreover, if a fin 196 is formed in an aluminum dies casting case as shown in drawing 6 R> 6 (b), thermal resistance will decrease further.

[0029] (Example 6) This example is shown in drawing 7 . Although the insulating electrode substrate 120 is joined to the aluminum dies casting case, the joint 162 of a case is constituted from this example by the heat pipe. The passage where a lid 153 is formed in the bottom and a refrigerant 106 flows is formed. Since the case consists of heat pipes, heat can reduce breadth thermal resistance in a longitudinal direction. In this example, since the dimension of the longitudinal direction of the case joint 162 is freely expandable, the heat dissipation

effectiveness increases further.

[0030] (Example 7) The power circuit partial circumference of this example is shown in drawing 8 . In drawing 8 (a), the resin ingredient 111 to close is overflowed, the pars convoluta lobuli corticalis renis 142 was formed, and the rear-face thin film metal plate 121 circumference is connected to a case 105 with connection ingredients, such as solder or adhesives, at the connection 143. Since the rear-face thin film metal plate 121 circumference has overflowed the resin ingredient 111 to close, connection of a connection 143 is easy for it. Moreover, in this example, since the pars convoluta lobuli corticalis renis 142 is formed and it is easy to ease the stress to the connection by internal pressure change of the cooling refrigerant 106, the dependability of connection improves. Moreover, since solder, adhesives, mechanical immobilization, or such junction structures that were compounded are used for the connection 143, connection dependability and waterproofness are high.

[0031] drawing 8 (b) -- drawing 8 (a) -- although saw the rear-face thin film metal plate 121 circumference, it has come out of the resin ingredient 111 to close similarly, the pars convoluta lobuli corticalis renis 144 is formed and it connects with the case 105 by the connection 145 with connection ingredients, such as solder or adhesives, the pars convoluta lobuli corticalis renis 144 serves as a S character-like configuration. For this reason, since it is further easy to ease the stress to the connection by internal pressure change of the cooling refrigerant 106, the dependability of connection improves further.

[0032] drawing 8 (c) -- drawing 8 (a) -- similarly, the rear-face thin film metal plate 121 circumference was seen, and has come out of the resin ingredient 111 to close, and it connects by the mechanical means of a bolt 147 etc. In addition, although not illustrated, the rear-face thin film metal plate 121 circumference overflows, solder or adhesives may be used together between the section 148 and a case 105, or a gasket or an O ring may be used.

[0033] (Example 8) This example is shown in drawing 9 . Although the insulating electrode substrate 120 of this example has the rear-face thin film metal plate 121 larger than an insulating substrate 110 like drawing 1 and it is the structure where only the rear-face thin film metal plate 121 is connected with the aluminum dies casting case 105 using the connection member 107, it connects with the aluminum dies casting case 105 by the front-face side of the rear-face thin film metal plate 121. Connection structure chooses solder, adhesives, etc. suitably. In this example, the refrigerant case 125 established independently [the aluminum dies casting case 105] has connected the passage of a refrigerant 106 to the rear-face thin film metal plate 121. The connection structure of this connection 126 chooses an O ring, a gasket, etc. suitably. Even if a refrigerant should leak by the connection 126 according to this example, since a refrigerant flows out outside, a refrigerant does not leak to the interior of the inverter with which a heavy current part exists.

[0034] (Example 9) This example is shown in drawing 10 (a). An insulating electrode substrate has the rear-face thin film metal plate 121 larger than an insulating substrate 181 like an example 1, and only the rear-face thin film metal plate 121 circumference is connected with the aluminum dies casting case 105 using the connection member 107. An insulating substrate 181 is only in the lower part of the surface thin film metal plate 103 in which the power semiconductor device 101 was carried, and connects the power semiconductor device 101 and a lead terminal 182 to the terminal strapping section with an aluminum wire etc. in this example using the lead terminal 182 prepared separately. It is filled up with the mold material 183 made of resin between a lead terminal 182 and the rear-face thin film metal plate 121, and insulation is maintained. The rear-face thin film metal plate 121 of an insulating substrate 181 is in contact with the cooling refrigerant 106 like the example 1. The mold material 183 of resin is filled up for example, with the transfer mold method.

[0035] Drawing 10 (b) is the flat-surface layout pattern of drawing 10 (a). The connection terminal area to the exterior consists of lead terminals 182, starts, and has the section. In addition, a lead terminal 182 is used for the post-assembly cast by integral construction shown in drawing 10 (c). In order to use a lead terminal 182 for the terminal strapping section, the connection process to the insulating electrode substrate of this part becomes unnecessary. Moreover, since there is no insulating substrate in a part for a lead terminal area, an insulating substrate is made to necessary minimum magnitude, and, for this reason, it is hard to produce the crack and crack of an insulating substrate.

[0036] As for drawing 10 (d), the surface thin film metal plate of an insulating electrode substrate

is united with a leadframe. That is, as shown in drawing 10 (e), the insulating substrate 181 and the rear-face thin film metal plate 121 are beforehand joined to the leadframe with which the lead terminal joint 201 and the lead terminal 202,204 were united, and a semiconductor device is carried in this component. The plane of composition with an insulating substrate 181 serves as a part of the lead terminal joint 201, and the lead terminal 204 outside a boundary line 203 is not joined. It assembles as such structure and a process is simplified further.

[0037] In each above example, although the case was explained as a product made from aluminum dies casting, the other quality of the materials are sufficient as resin, other aluminium alloys, Mg alloy, etc. Moreover, a power component can be suitably chosen according to the conditions of systems, such as power metal-oxide semiconductor field effect transistor and a power transistor, besides IGBT.

[0038]

[Effect of the Invention] Since the thermal resistance between a power component and a refrigerant can be easily reduced according to this invention as stated above, inverter equipment can be miniaturized.

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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view of the inverter of an example 1.
[Drawing 2] It is the flat-surface layout pattern of the power circuit section of the inverter of an example 1.
[Drawing 3] It is the sectional view of the power circuit section of the inverter of an example 2.
[Drawing 4] It is the sectional view of the power circuit section of the inverter of an example 3.
[Drawing 5] It is the sectional view of the power circuit section of the inverter of an example 4.
[Drawing 6] It is the sectional view of the power circuit section of the inverter of an example 5.
[Drawing 7] It is the sectional view of the power circuit section of the inverter of an example 6.
[Drawing 8] It is the sectional view of the power circuit section of the inverter of an example 7.
[Drawing 9] It is the sectional view of the inverter of an example 8.
[Drawing 10] It is the cross section and flat-surface layout pattern of an inverter of an example 9.
[Drawing 11] It is the sectional view of the inverter of the conventional technique.
[Drawing 12] It is the sectional view of the inverter of other conventional techniques.
[Drawing 13] It is the circuitry Fig. of the inverter of an example 1.
[Description of Notations]
101,302 -- A power semiconductor device (IGBT), 103,161,169,801 -- Surface thin film metal plate, 105,151 -- A case, 106,197 -- A refrigerant, 107 -- The connection member of a rear-face thin film metal plate and a case, 109,115 -- A connection terminal, 110,181 -- An insulating substrate, 111 -- Resin ingredient, 116 -- A control circuit substrate, 117,307 -- A capacitor, 118 -- Connector, 120,129 -- An insulating electrode substrate, 121,140 -- Rear-face thin film metal plate, 125 -- A refrigerant case, 126 -- A refrigerant case connection, 141 -- Irregularity of a rear-face thin film metal plate, 142,144 -- The rear-face thin film metal plate pars convoluta lobuli corticalis renis, 143,145 -- The connection of a rear-face thin film metal plate and a case, 146 -- The heat carrier path of a heat pipe, 147 -- A bolt, 148 -- A rear-face thin film metal plate ******, 153 -- A lid, 155,162 -- A case joint, 182,202,204 -- Lead terminal, 183 -- Mold material, 191,192,193 -- The terminal strapping section, 195,303 -- Free wheel diode, 196 -- A fin, 201 -- A lead terminal joint, 203 -- Lead terminal joint boundary, 210 [-- The N side wiring, 306 / -- Load wiring, 802,805 / -- A jointing material for corrugated fibreboard, 803,806,807 / -- A metal plate, 804 / -- It overflows and is the section.] -- An aluminum wire, 301 -- A plane 1 part power circuit, 304 -- The P side wiring, 305

[Translation done.]

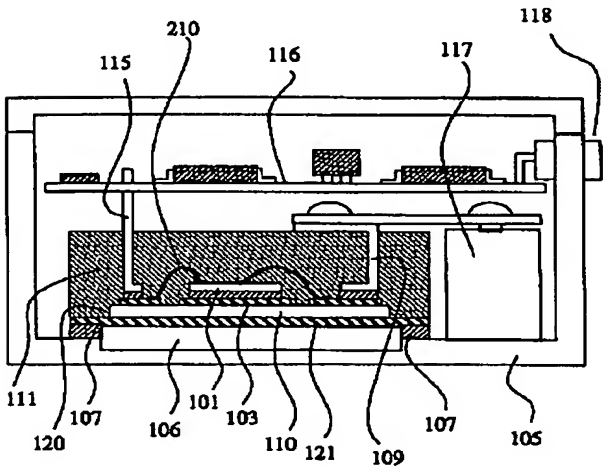
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

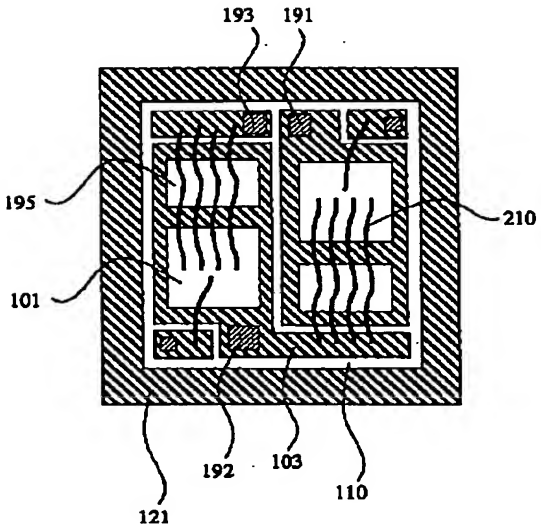
[Drawing 1]

図 1



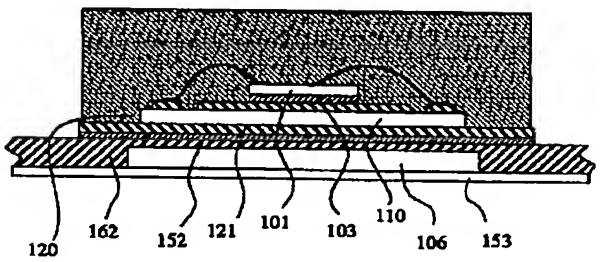
[Drawing 2]

図 2



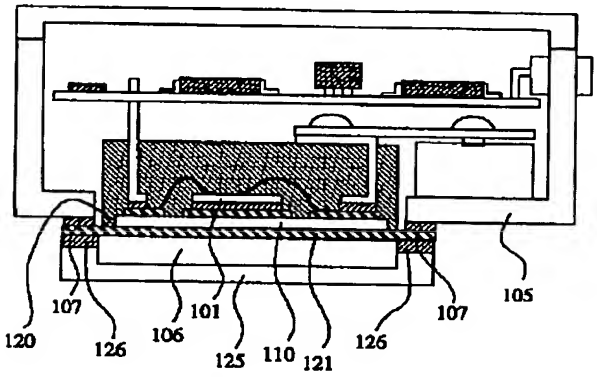
[Drawing 7]

図 7



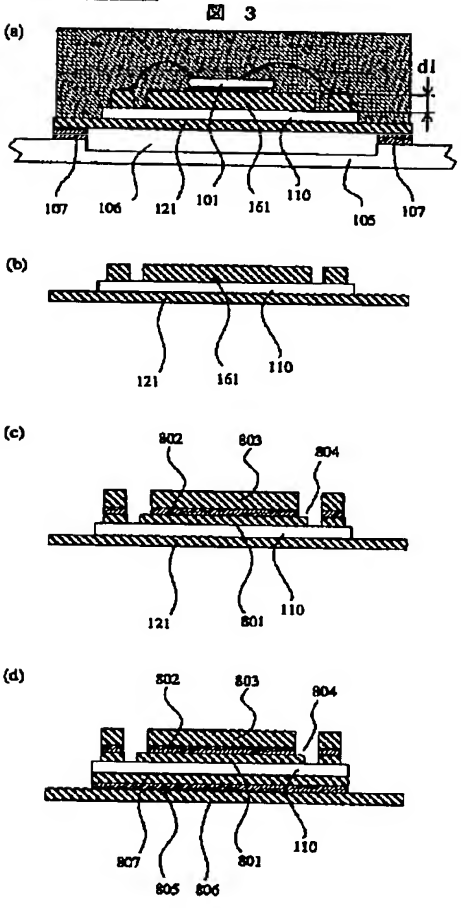
[Drawing 9]

図 9



[Drawing 3]

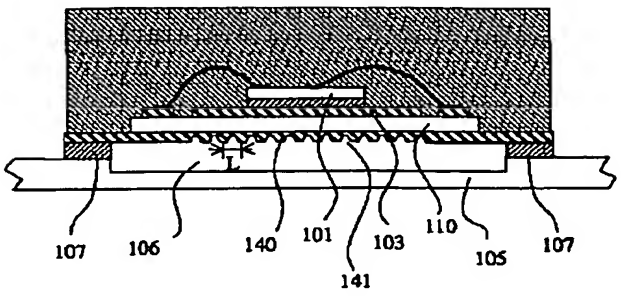
図 3



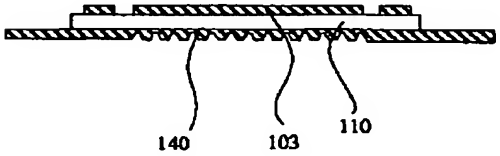
[Drawing 4]

図 4

(a)



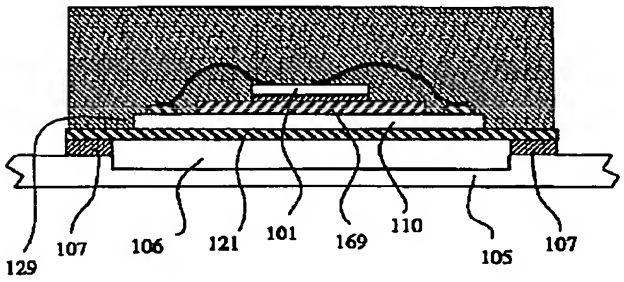
(b)



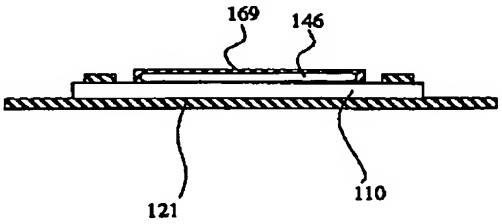
[Drawing 5]

図 5

(a)

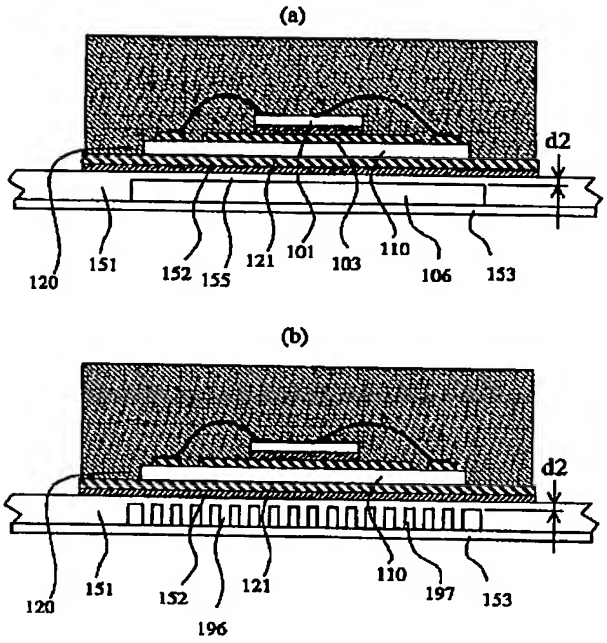


(b)



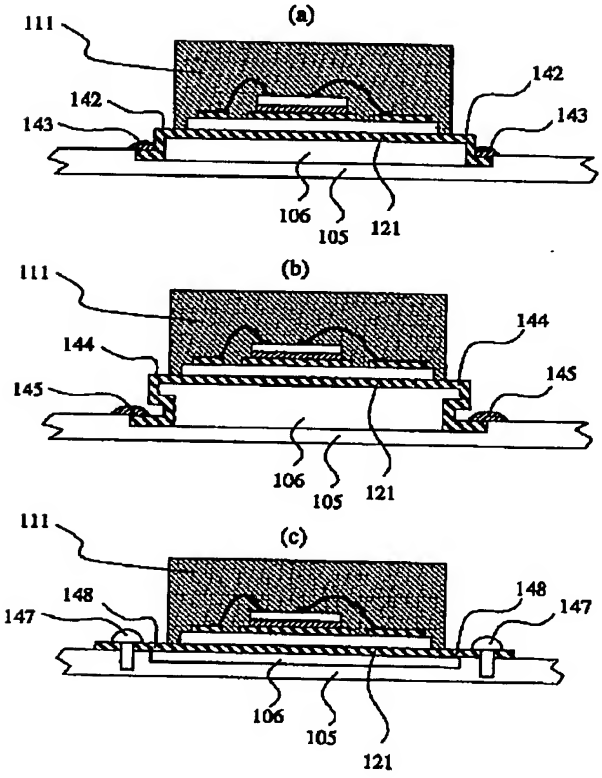
[Drawing 6]

図 6



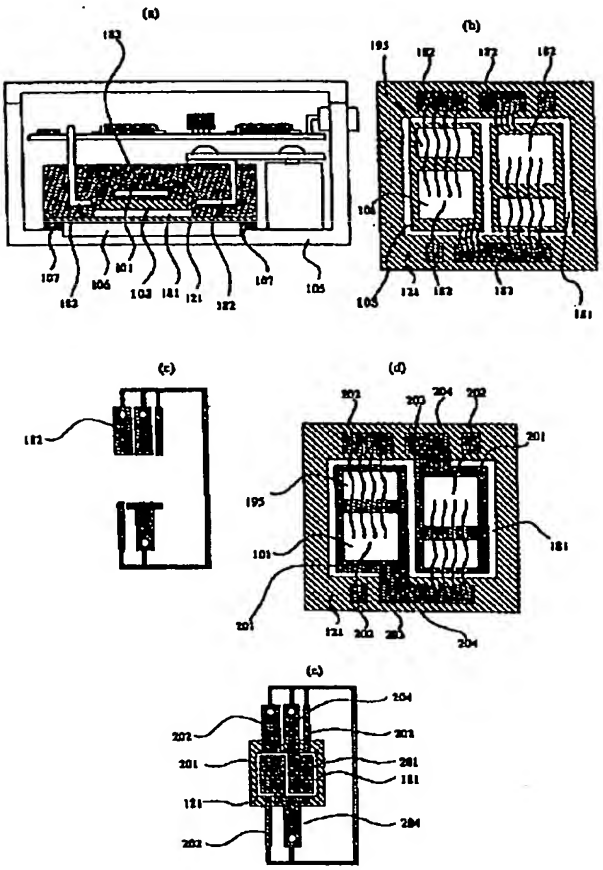
[Drawing 8]

図 8



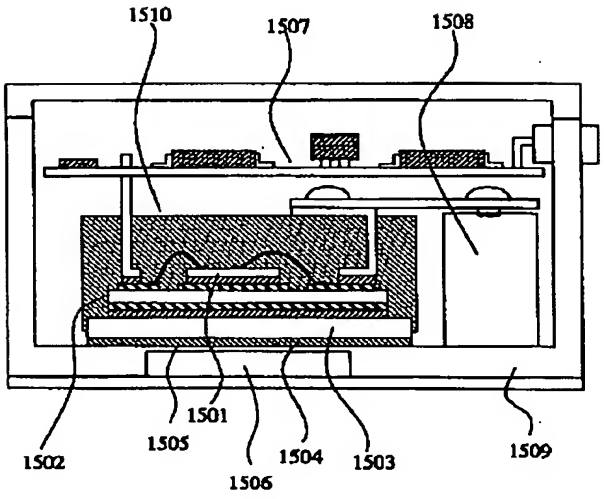
[Drawing 10]

図 10



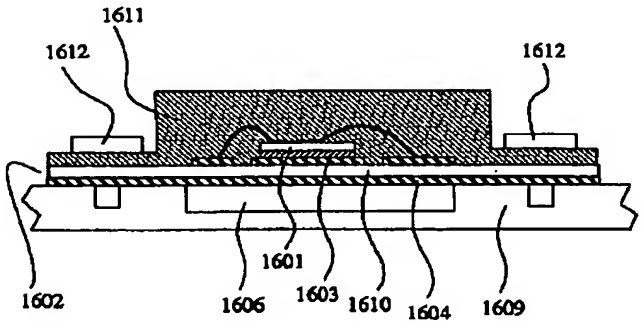
[Drawing 11]

図 11



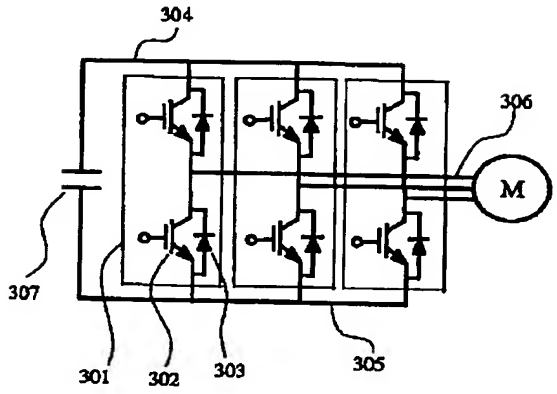
[Drawing 12]

図 12



[Drawing 13]

図 13



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Ｈ０１Ｌ　23/427		Ｈ０５Ｋ　7/20	Ｍ	５Ｈ００７
23/473			Ｒ	
25/07		Ｈ０１Ｌ　23/46	Ｂ	

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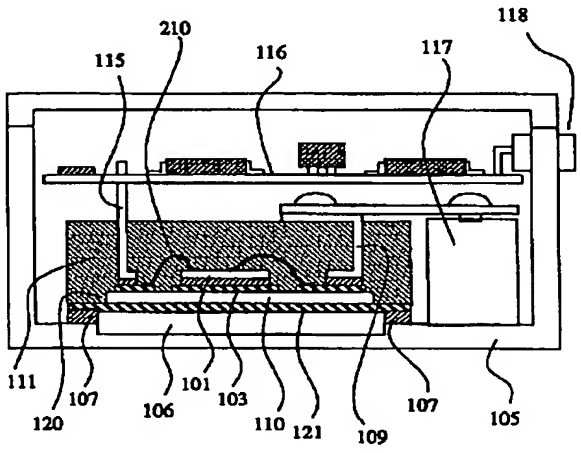
最終頁に続く

(54)【発明の名称】　インバータ装置

(57)【要約】
【課題】防水性を確保しつつ絶縁基板の割れなどの恐れがない接続構造でパワー素子と冷媒間の熱抵抗を低減し、小形で高い効率のインバータ装置を実現する。
【解決手段】本発明のインバータ装置は、絶縁基板の裏面電極板が絶縁基板より大きく、裏面電極板周辺がケースに接合され、冷媒の流路を絶縁基板の直下に設けた。また、絶縁基板の表面電極板は０．５㎜以上の厚さを有するかあるいは、ヒートパイプで構成し、裏面電極板に３㎜以下のピッチの凹凸を設け、裏面電極板とケースの接合は、半田あるいは接着剤あるいは機械的固定あるいはこれらを複合した。

図１



【特許請求の範囲】

【請求項１】パワー素子と、電極板が表裏に接合され前記パワー素子が搭載された絶縁基板及び端子などからなるパワー回路部と、冷却冷媒の流路が形成されたケースと、制御回路部分とからなるインバータ装置において、前記電極板が接合された絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、前記冷却冷媒側の電極板の周辺部はケースに接合され、電極板が接合された絶縁基板の裏面は冷却冷媒で冷却されていることを特徴とするインバータ装置。

【請求項２】電極板が接合された絶縁基板のパワー素子側の電極板は０．５㎜ 以上の厚さであることを特徴とする請求項１記載のインバータ装置。

【請求項３】電極板が接合された絶縁基板の冷却冷媒側の電極板は３㎜以下のピッチの凹凸が設けられていることを特徴とする請求項１記載のインバータ装置。

【請求項４】電極板が接合された絶縁基板のパワー素子側の電極板はヒートパイプで構成されていることを特徴とする請求項１記載のインバータ装置。

【請求項５】電極板が接合された絶縁基板の冷却冷媒側電極板周辺部と冷却冷媒の流路が形成されたケースの接合は、半田あるいは接着剤あるいは機械的固定あるいはこれらの複合された接合構造とすることを特徴とする請求項１記載のインバータ装置。

【請求項６】電極板が接合された絶縁基板の冷却冷媒側の電極板は表面側がケースに接合され、裏面側が冷却冷媒の流路を構成する他のケース部材に接合されていることを特徴とする請求項１記載のインバータ装置。

【請求項７】パワー素子と、電極板が表裏に接合され前記パワー素子が搭載された絶縁基板及び端子などからなるパワー回路部と、冷却冷媒の流路が形成されたケースと、制御回路部分とからなるインバータ装置において、前記電極板が接合された絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、前記冷却冷媒側の電極板はケース部分に全面が接合され、前記ケース部分は冷却冷媒で冷却されていることを特徴とするインバータ装置。

【請求項８】パワー素子と、電極板が表裏に接合され前記パワー素子が搭載された絶縁基板及び端子などからなるパワー回路部と、冷却冷媒の流路が形成されたケースと、制御回路部分とからなるインバータ装置において、前記電極板が接合された絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、前記冷却冷媒側の電極板はケース部分に全面が接合され、少なくとも前記絶縁基板が接合するケース部分がヒートパイプからなることを特徴とするインバータ装置。

【請求項９】パワー素子と、電極板が表裏に接合され前記パワー素子が搭載された絶縁基板及び端子などからなるパワー回路部と、冷却冷媒の流路が形成されたケースと、制御回路部分とからなるインバータ装置において、前記電極板が接合された絶縁基板の冷却冷媒側の電極板

は絶縁基板より大きく、パワー素子の封止はトランスファーモールド構造であって、パワー素子と、外部端子と一体となっている電極端子がワイヤあるいは接続板で接続されていることを特徴とする請求項１～８記載のインバータ装置。

【請求項１０】金属板が両面に接合されたセラミック絶縁基板において、少なくとも表面金属板の一部は０．５ｍｍ 以上の厚さを有し、裏面金属板は前記セラミック絶縁基板より広い面積でセラミック絶縁基板に接合されていることを特徴とするセラミック絶縁基板。

【請求項１１】金属板が両面に接合されたセラミック絶縁基板において、裏面金属板には概略全面にわたって凹凸が設けられていることを特徴とするセラミック絶縁基板。

【請求項１２】金属板が両面に接合されたセラミック絶縁基板において、少なくとも片面の金属板の一部は板状ヒートパイプからなることを特徴とするセラミック絶縁基板。

【請求項１３】金属板が両面に接合されたセラミック絶縁基板において、少なくとも表面金属板の一部はリードフレームと一体となっておりリードフレームの一部が前記セラミック絶縁基板に接合されていることを特徴とするセラミック絶縁基板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はインバータ構造に関り、特に効率的なパワー素子の冷却を実現するインバータ構造に関する。

【０００２】

【従来の技術】インバータの小型化，高効率化を実現するためパワー半導体素子に通電し安定な動作を確保するためには冷却機構を設けることが必要である。すなわちIGBTやパワーＭＯＳ等のパワー半導体素子からなるインバータ装置においては、素子の安定動作を確保するため半導体素子の動作時の温度が所定の限界動作温度を越えないように空冷ないし冷媒を用いた液冷、あるいは、沸騰冷却などといった冷却機構が備えられている。近年、インバータ装置の小型化，高効率化への要求から素子の電流密度は増加傾向にあり、これに伴って素子の発熱密度は増加してきているため、素子の温度上昇を抑えるため冷却機構の高効率化が求められてきている。特に、ハイブリッド電気自動車（ＨＥＶ）や燃料電池車（ＦＣＥＶ）等の自動車用電気駆動系に適用されるインバータ装置においては、設置面積や重量の制限のため小型で高効率の冷却構造への要求は高い。

【０００３】特開平６－３０３７０４号公報には図１１に示す冷却構造が開示されている。図１１では、ＩＧＢＴ等のパワー半導体素子１５０１が絶縁基板１５０２上に半田等で接合されており、さらにベース金属板１５０３に半田接合されたパワー半導体モジュール１５１０が

熱伝導性グリース１５０４を介して冷却部１５０５に取り付けられている。絶縁基板は窒化アルミニウム（ＡｌＮ）やアルミナ(Al_2O_3)等のセラミック基板に電極用金属薄板が接合されている。このようなパワー回路部モジュール１５１０にコンデンサ１５０８，制御回路基板１５０７等が接続され、冷却部１５０５と一体をなすケース１５０９に搭載されてインバータ装置を構成する。冷却部１５０５には、冷却水１５０６の流路が形成されている。冷却水は循環水冷系のポンプを用いて外部放熱部と循環している。パワー半導体素子１５０１で発生した熱は、絶縁基板１５０２，ベース金属板１５０３，冷却部１５０５などへ熱伝導し、流路の熱伝達表面で冷却水１５０６に熱伝導し、ポンプで冷却水が外部放熱部に移動した後、温度上昇した冷却水と外気が熱交換して外部に排出される。

【０００４】また、図１２に示した特開平９－１２１５５７号公報に絶縁基板裏面を直接冷却する構造が開示されている。この構造においては、ＩＧＢＴ等のパワー半導体素子１６０１が絶縁基板１６０２上に半田等で接合されており、絶縁基板1602が延在した部分をボルトなどの締付手段１６１２で封止部材１６１１と共にケース１６０９に取り付けている。絶縁基板は窒化アルミニウム（ＡｌＮ）やアルミナ（Al_2O_3）等のセラミック基板１６１０に電極用金属薄板１６０３，１６０４が接合したものである。絶縁基板１６０２の裏面はケース１６０９に設けられた流路を通る冷却水１６０６で冷却される。

【０００５】

【発明が解決しようとする課題】前記図１１の構造では発熱部であるパワー半導体素子１５０１と冷却水1506の間にいくつもの層が介在しているため十分な冷却能力が得られず、素子の電流密度を増加し小型化することには限界がある。また、前記図１２の構造では大型の絶縁基板を取り付けボルトで締めつけるため、絶縁基板の割れが生じやすく、取り付け占有面積も大きい問題がある。

【０００６】本発明の目的は、電流密度を増加し、インバータを小型化しても半導体素子の温度上昇を効果的に抑制できる小形高効率インバータ構造を実現するために、小型で簡易な方法でパワー素子と冷媒間の熱抵抗を低減する構造を提供することである。また、本発明の目的は、防水性を確保しつつ絶縁基板の割れなどの恐れのない接続構造で熱抵抗を低減する構造を提供し、パワー素子の絶縁基板を小型化し組み立ての容易な構造を提供することである。

【０００７】

【課題を解決するための手段】本発明のインバータ装置は、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、冷却冷媒側の電極板周辺がケースに接合され、冷却冷媒の流路を絶縁基板の直下に設け、絶縁基板のパワー素子側の電極板は０．５㎜ 以上の厚さであって、絶縁基板の冷却冷媒側の電極板は３㎜以下のピッチの凹凸を設けた。

【０００８】本発明のインバータ装置は、絶縁基板のパワー素子側の電極板がヒートパイプで構成されていて、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、ケース部分に全面が接合され、前記ケース部分は冷却冷媒で冷却されている。本発明のインバータ装置は、絶縁基板が全面接合するケース部分がヒートパイプからなる構造である。

【０００９】本発明のインバータ装置は、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、絶縁基板と冷却冷媒の流路が形成されたケースの周辺部の接合は、半田あるいは接着剤あるいは機械的固定あるいはこれらの複合された接合構造である。

【００１０】本発明のインバータ装置は、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、絶縁基板と冷却冷媒の流路が形成されたケース周辺部の接合部の電極板は折り曲げられた構造であり、冷却冷媒側の電極板の表面側がケースに接合され、裏面側が冷却冷媒の流路を構成する他のケース部材に接合されていて、パワー素子の封止はトランスファーモールド構造であって、冷却冷媒に絶縁基板の裏面電極板が接している。

【００１１】本発明のインバータ装置では、冷却冷媒の流路を絶縁基板の直下に設けたことにより、発熱部であるパワー半導体素子と冷却冷媒の間は絶縁基板と薄い電極金属板のみとなるため熱抵抗が大幅に低減される。また、本発明のインバータ装置は、絶縁基板の冷却冷媒側の電極板が絶縁基板より大きいため組み立てあるいは実使用による割れやクラックを防止できる。特に、ケースとの接合部に絶縁基板がないため接合作業が容易である。

【００１２】本発明のインバータ装置は、絶縁基板のパワー素子側の電極板厚さが０．５㎜以上であるので、発熱部のパワー半導体素子の熱を効果的に横方向に広げることができ、伝熱面積が拡がり熱抵抗が低減する。また、絶縁基板の冷却冷媒側の電極板は３㎜以下のピッチの凹凸があるので、冷却冷媒に乱流が生じやすくなり、熱抵抗が低減する。

【００１３】本発明のインバータ装置は、絶縁基板のパワー素子側の電極板がヒートパイプなので、発熱部のパワー半導体素子の熱を効果的に横方向に広げることができ、伝熱面積が拡がり熱抵抗が低減する。また、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、ケース部分に全面が接合され、前記ケース部分は冷却冷媒で冷却されているので、防水性を確保しつつ熱抵抗が低減する。

【００１４】本発明のインバータ装置は、絶縁基板が全面接合するケース部分がヒートパイプからなるので、防水性を確保しつつ熱抵抗がさらに低減する。また、絶縁基板の冷却冷媒側の電極板は絶縁基板より大きく、絶縁

基板の裏面電極板周辺部と冷却冷媒の流路が形成されたケースの接合は、半田あるいは接着剤あるいは機械的固定あるいはこれらの複合された接合構造であるので、小さい面積で防水性を確保した接合ができる。

【００１５】

【発明の実施の形態】本発明の実施例を以下図面を用いて説明する。

（実施例１）図１に本実施例のインバータ装置の断面図を示す。図１に示すようにＩＧＢＴ等のパワー半導体素子１０１が絶縁電極基板１２０上に半田等で接合している。絶縁電極基板１２０は例えば窒化アルミニウム（ＡｌＮ）やアルミナ(Al_2O_3)あるいは窒化珪素（ＳｉＮ）等のセラミック絶縁基板１１０に電極用金属薄板が接合されたものである。絶縁電極基板１２０表面には電極用の薄膜金属板１０３が接合されており、裏面には薄膜金属板１２１が接合されている。パワー半導体素子１０１表面のエミッタないしゲート電極はアルミニウムワイヤ２１０で薄膜金属板１０３に接続している。これら素子側の部分は接続端子１０９，１１５が接合された後、例えば樹脂材料１１１としてパワー半導体素子１０１付近はシリコーンゲルで封止し、その周りはＰＰＳまたはＰＢＴ等の樹脂製ケース材で構成している。あるいは樹脂材料１１１はトランスファーモールド構造である。なお、図１では説明の都合上、パワー半導体素子は１個であるが、通常は複数個配置されている。接続端子１０９は主端子であってコンデンサ１１７ないしは負荷等に接続され外部にあるモータに接続され、接続端子１１５は制御端子であって制御回路基板１１６に接続され、コネクタ１１８から外部信号を入力してインバータ動作を行う。インバータ装置全体はケース１０５内に収納されていて、図１３に示すインバータ回路を構成する。なお、図１３では制御回路や電流センサなどの構成部品は省略している。

【００１６】図２は本実施例の絶縁電極基板１２０及びパワー素子の平面レイアウト図である。図１３の回路構成では１相分パワー回路３０１に相当するもので、例えばパワー素子としてＩＧＢＴ１０１，３０２とフリーホイールダイオード素子１９５，３０３が各１個で１アーム分であり、Ｐ側配線３０４に接続される端子接続部１９１，Ｎ側配線３０５に接続される端子接続部１９３，モータが接続している負荷配線３０６に接続される端子接続部１９２などが配置されている。

【００１７】本実施例では絶縁電極基板１２０がアルミダイキャスト等からなるインバータ装置のケース１０５に半田あるいは接着剤あるいは機械的固定あるいはこれらの複合された接合構造により接合され、絶縁電極基板１２０裏面には冷却用の冷媒１０６がある構造であって、裏面薄膜金属板１２１が絶縁基板１１０より大きいものであり、裏面薄膜金属板１２１周辺のみがアルミダイキャストケース１０５と接続部材１０７を用いて接続される。

【００１８】アルミダイキャストケース１０５と絶縁電極基板１２０とは裏面薄膜金属板１２１周辺が接続されている。アルミダイキャストには例えば３～１４％Ｓｉ含有Ａｌ合金あるいは、Ｚｎ含有Ａｌ合金が適用できる。接続部材１０７の半田には、低融点の共晶半田あるいはＢｉ系のＰｂフリー半田が適用できる。この部分の半田には高い熱伝導性を必要としないため半田厚さを例えば０．２㎜以上にして半田への熱応力を軽減する。また、半田を接合部材として用いることにより裏面薄膜金属板１２１とアルミダイキャストケース１０５が電気的に接続されるため電磁シールド性が向上する。

【００１９】また、接続部材１０７が接着剤の場合は例えばエポキシ樹脂系接着剤，ポリウレタン系接着剤，シリコーンゴム系接着剤が適用できる。エポキシ樹脂系接着剤としては例えばウレタン変性エポキシ樹脂を含有する２液性接着剤（例えば（株）横浜ゴム製）、あるいは、油面接着性を有する１液性接着剤（例えば宇部興産（株）製）があり、ポリウレタン系接着剤としては例えば１成分型弾性接着剤（例えばシーカ製）がある。接続部材１０７が接着剤の場合、半田接続の場合のような高温のプロセスを必要としないため製作が容易である。

【００２０】冷媒１０６は例えば、不凍液，水，油，代替フロンあるいは空気などであって、適宜設定された流速で流路を流れている。不凍液の場合には例えばエチレングリコール系不凍液（商品名ＬＬＣ、デンソー（株）製）が適用できる。裏面薄膜金属板１２１の表面は冷媒による腐食を防止するためＮｉＰ，ＮｉＢなどのＮｉメッキ等の処理が施される。また、流路のアルミダイキャストの表面は例えばニッケルクロムメッキを施して耐食性を向上させる方が好ましい。冷媒１０６は別途設けられたポンプで循環され、ラジエータで冷却された後インバータ部分に再度循環されるため温度は一定値以下に保たれる。

【００２１】本実施例ではインバータ動作時に発熱するパワー半導体素子１０１と冷媒106との間には絶縁電極基板１２０とパワー素子を接合する半田しかないため熱抵抗が極めて小さい。従ってパワー半導体素子１０１の電流密度を増加して発熱密度が増加しても最大動作温度を越えることがなく安定に動作できるため、パワー素子を小型化でき、インバータ装置が小型になる。

【００２２】また、本実施例では接続部が金属同士の接続のため裏面薄膜金属板１２１とアルミダイキャストケース１０５との接続を行いやすく、作業性が向上し、防水性を確保しやすい。また、絶縁基板１１０が比較的小さく、また、絶縁基板１１０の下部に接続部材１０７がないため組み立てあるいは実使用による絶縁基板110の割れやクラックを防止できる。また、パワー半導体素子１０１の発生する熱は、表面薄膜金属板１０３，絶縁基板１１０，裏面薄膜金属板１２１である程度拡がりつつ

裏面薄膜金属板１２１表面で冷媒１０６に伝達されるため冷媒１０６の流路を形成しているアルミダイキャストケース１０５の温度上昇はさほど大きなものではない。従って接続部材１０７に加わる熱応力は低減される。

【００２３】（実施例２）図３（ａ）に本実施例のインバータのパワー回路部分を示す。絶縁電極基板の表面薄膜金属板１６１はＣｕあるいはＡｌあるいはＣｕＭｏ，ＣｕＷ等の複合材料あるいはＣｕ，Ｗの積層材料から構成されるが、その厚さｄ１は０．５㎜ 以上であり、望ましくは０．５㎜ 以上２㎜以下である。これによってパワー半導体素子１０１で発生する熱が表面薄膜金属板１６１で十分に広がり、熱抵抗が低減する。表面薄膜金属板１６１のパターン周辺端部は厚さを薄くするかあるいは凹凸を形成してあるので、ヒートサイクル時の絶縁基板のクラックや割れは起こりにくい。また、絶縁基板はＡｌＮなど適宜選択されるが、特にＳｉＮは機械強度に優れているため表面薄膜金属板１６１が厚くなっても絶縁基板のクラックや割れが起こりにくく好ましい。絶縁基板のそり及び割れを避けるために実質的に表面薄膜金属板１６１が厚くなるのに対応して裏面薄膜金属板１２１も厚くするので、この部分で熱が広がり、熱抵抗が低減する。なお、図３（ｂ）は絶縁電極基板単体の構造を示す。

【００２４】図３（ｃ）は絶縁電極基板単体の他の構造で表面薄膜金属板は実質的に内側金属板８０１，接合材８０２，外側金属板８０３の３層からなっており、これらの合計の厚さが０．５㎜ 以上である。なお、図示していないが内側金属板８０１は直接接合あるいはロー材などの公知の接合手段で絶縁基板１１０に接合されてよく、メタライズ層として形成されていてもよい。通常は内側金属板８０１は0.1㎜ 以下と薄くこのためパターン端部での絶縁基板への応力を緩和できる。特に、はみ出部８０４を設けると応力緩和効果が大きい。接合材８０２は直接接合，ロー材あるいは半田などを用いる。外側金属板８０３は合計厚さを確保するため、例えば０．４ｍｍ 以上にする。このような構造とすることにより絶縁基板への過大な応力を緩和し信頼性が確保できる。図３（ｄ）は裏面薄膜金属板についても内側金属板８０７，接合材８０５，外側金属板８０６の３層として表面薄膜金属板との応力バランスをとり信頼性を確保した。図３（ｄ）では外側金属板８０６が絶縁基板より大きい。

【００２５】（実施例３）図４(ａ)に本実施例を示す。本実施例では裏面薄膜金属板１４０に凹凸１４１を設けた。凹凸１４１の高さ，幅，間隔等の寸法Ｌは３㎜以下である。このような凹凸１４１は冷媒の流動方向に水平あるいは垂直の縞状、あるいは、ピン状の突起、あるいは、円形の穴の繰り返しなど所望の形状及び配列に設定する。このような凹凸で冷媒との熱伝達境界面積が増加するため熱伝達率が向上し熱抵抗がさらに低減する。また、このような凹凸の寸法Ｌを例えば１㎜以下にすれば、金属板のプレス成形などで凹凸を容易に形成できる。なお、図４（ｂ）は絶縁電極基板単体の構造を示す。

【００２６】（実施例４）図５に本実施例を示す。本実施例では表面薄膜金属板１６９はヒートパイプで構成されている。ヒートパイプは内部に熱媒体が移動する経路があり、図５(ｂ)に示すように本実施例ではこの経路１４６は絶縁基板１１０に平行な方向である。表面薄膜金属板１６９がヒートパイプのため、パワー半導体素子１０１で発生する熱はヒートパイプ内部の熱媒体によって横方向に移動する。このため熱抵抗が低減する。ヒートパイプはＡｌあるいはＣｕなどの材質で構成され、公知の蛇行細管などでもよい。絶縁基板１１０と表面薄膜金属板１６９であるヒートパイプとの接合にロー材を用いて絶縁電極基板１２９を構成してもよい。あるいは、絶縁基板１１０を樹脂で構成し、ヒートパイプと樹脂を熱圧着などの方法で接着してもよい。この場合の樹脂は例えばシリコーン系の樹脂材料である。本実施例ではヒートパイプの熱輸送能力によって横方向への熱広がりが大きいため表面薄膜金属板１６９の横方向の寸法を大きくして熱抵抗を低減できる。さらに、裏面薄膜金属板１２１をヒートパイプにする構成でも同様な効果が得られる。

【００２７】（実施例５）図６（ａ）に本実施例を示す。本実施例では絶縁電極基板１２０は全面がアルミダイキャストケース１５１に接合されている。接合には半田１５２を用いる。アルミダイキャストケース１５１には下側に蓋１５３を設けて冷媒１０６が流れる流路を形成する。絶縁電極基板１２０と接合しているアルミダイキャストケース接合部１５５の厚さｄ２は例えば０．５ｍｍ 以下の厚さにして熱抵抗を低減する。

【００２８】本実施例では冷媒の流路にインバータ内部に通じる接合部分がないため、防水性が高い。また、図６（ｂ）に示すようにアルミダイキャストケースにフィン１９６を設けると熱抵抗がさらに低減する。

【００２９】（実施例６）図７に本実施例を示す。本実施例では絶縁電極基板１２０はアルミダイキャストケースに接合されているがケースの接合部１６２がヒートパイプで構成されている。下側には蓋１５３を設けて冷媒１０６が流れる流路が形成されている。ケースがヒートパイプで構成されているため横方向に熱が広がり熱抵抗が低減できる。本実施例ではケース接合部１６２の横方向の寸法を自由に拡大できるため放熱効果がさらに増加する。

【００３０】（実施例７）図８に本実施例のパワー回路部分周辺を示す。図８（ａ）では裏面薄膜金属板１２１周辺は封止する樹脂材料１１１からはみ出ており、曲部１４２が設けられ、半田あるいは接着剤等の接続材料で接続部１４３でケース１０５に接続している。裏面薄膜金属板１２１周辺は封止する樹脂材料１１１からはみ出

ているため接続部１４３の接続作業が容易である。また、本実施例では曲部１４２が設けられているため冷却冷媒１０６の内圧変化による接続部への応力を緩和しやすいので接続の信頼性が向上する。また、接続部１４３には半田あるいは接着剤あるいは機械的固定あるいはこれらの複合された接合構造を用いているので接続信頼性と防水性が高い。

【００３１】図８（ｂ）では、図８（ａ）同様裏面薄膜金属板１２１周辺は封止する樹脂材料１１１からはみ出ており、曲部１４４が設けられ、半田あるいは接着剤等の接続材料で接続部１４５でケース１０５に接続されているが、曲部１４４はＳ字状の形状となっている。このため冷却冷媒１０６の内圧変化による接続部への応力をさらに緩和しやすいため、接続の信頼性がさらに向上する。

【００３２】図８（ｃ）では、図８（ａ）同様裏面薄膜金属板１２１周辺は封止する樹脂材料１１１からはみ出ており、ボルト１４７などの機械的手段で接続されている。なお、図示していないが裏面薄膜金属板１２１周辺のはみ出部１４８とケース１０５の間には半田あるいは接着剤が併用されてもよいし、あるいはガスケットあるいはＯリングを用いてもよい。

【００３３】（実施例８）図９に本実施例を示す。本実施例の絶縁電極基板１２０は図１と同様に裏面薄膜金属板１２１が絶縁基板１１０より大きく、裏面薄膜金属板１２１のみがアルミダイキャストケース１０５と接続部材１０７を用いて接続される構造であるが、裏面薄膜金属板１２１の表面側でアルミダイキャストケース１０５と接続される。接続構造は半田，接着剤などを適宜選択する。本実施例では冷媒１０６の流路はアルミダイキャストケース１０５とは別に設けた冷媒ケース１２５が裏面薄膜金属板１２１に接続している。この接続部１２６の接続構造はＯリングやガスケットなどを適宜選択する。本実施例によると万一、接続部１２６で冷媒の漏れても冷媒は外部に流出するため強電部分が存在するインバータ内部に冷媒が漏れない。

【００３４】（実施例９）図１０（ａ）に本実施例を示す。絶縁電極基板は実施例１と同様に裏面薄膜金属板１２１が絶縁基板１８１より大きいものであり、裏面薄膜金属板１２１周辺のみがアルミダイキャストケース１０５と接続部材１０７を用いて接続される。本実施例では、絶縁基板１８１がパワー半導体素子１０１が搭載された表面薄膜金属板１０３の下部のみにあり、端子接続部には別途設けたリード端子１８２を用い、パワー半導体素子１０１とリード端子１８２をアルミニウムワイヤ等で接続する。リード端子１８２と裏面薄膜金属板１２１との間には樹脂製のモールド材１８３を充填して絶縁性を保つ。冷却冷媒１０６には実施例１同様に絶縁基板１８１の裏面薄膜金属板１２１が接している。樹脂のモールド材１８３は例えばトランスファーモールド法で充填する。

【００３５】図１０（ｂ）は図１０（ａ）の平面レイアウト図である。外部への接続端子部はリード端子１８２で構成されていて、立ち上がり部を有する。なお、リード端子１８２は図１０（ｃ）に示す一体構造で成型された後組み立てに使用される。端子接続部にはリード端子１８２を用いるため、この部分の絶縁電極基板への接続工程が不要になる。また、リード端子部分に絶縁基板がないため、絶縁基板を必要最小限の大きさにでき、このため絶縁基板の割れやクラックが生じにくい。

【００３６】図１０（ｄ）は、絶縁電極基板の表面薄膜金属板がリードフレームと一体となったものである。すなわち、図１０（ｅ）に示すようにリード端子接合部２０１とリード端子２０２，２０４とが一体となったリードフレームにあらかじめ絶縁基板１８１，裏面薄膜金属板１２１が接合されており、この部品に半導体素子が搭載される。絶縁基板１８１との接合面はリード端子接合部２０１の部分となり、境界線２０３より外側のリード端子２０４は接合されていない。このような構造として組み立て工程がさらに簡略化される。

【００３７】以上の各実施例ではケースはアルミダイキャスト製として説明したが樹脂、他のアルミニウム合金，Ｍｇ合金などその他の材質でも構わない。また、パワー素子はＩＧＢＴの他にパワーＭＯＳＦＥＴ，パワートランジスタ等システムの条件に応じて適宜選択できる。

【００３８】

【発明の効果】以上述べたように本発明によれば容易にパワー素子と冷媒間の熱抵抗を低減できるため、インバータ装置を小型化できる。

【図面の簡単な説明】

【図１】実施例１のインバータの断面図である。

【図２】実施例１のインバータのパワー回路部の平面レイアウト図である。

【図３】実施例２のインバータのパワー回路部の断面図である。

【図４】実施例３のインバータのパワー回路部の断面図である。

【図５】実施例４のインバータのパワー回路部の断面図である。

【図６】実施例５のインバータのパワー回路部の断面図である。

【図７】実施例６のインバータのパワー回路部の断面図である。

【図８】実施例７のインバータのパワー回路部の断面図である。

【図９】実施例８のインバータの断面図である。

【図１０】実施例９のインバータの断面模式図及び平面レイアウト図である。

【図１１】従来技術のインバータの断面図である。

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【図１２】他の従来技術のインバータの断面図である。
【図１３】実施例１のインバータの回路構成図である。
【符号の説明】
１０１，３０２…パワー半導体素子（ＩＧＢＴ）、１０３，１６１，１６９，８０１…表面薄膜金属板、１０５，１５１…ケース、１０６，１９７…冷媒、１０７…裏面薄膜金属板とケースの接続部材、１０９，１１５…接続端子、110,１８１…絶縁基板、１１１…樹脂材料、１１６…制御回路基板、１１７，３０７…コンデンサ、１１８…コネクタ、１２０，１２９…絶縁電極基板、１２１，１４０…裏面薄膜金属板、１２５…冷媒ケース、１２６…冷媒ケース接続部、１４１…裏面薄膜金属板の＊

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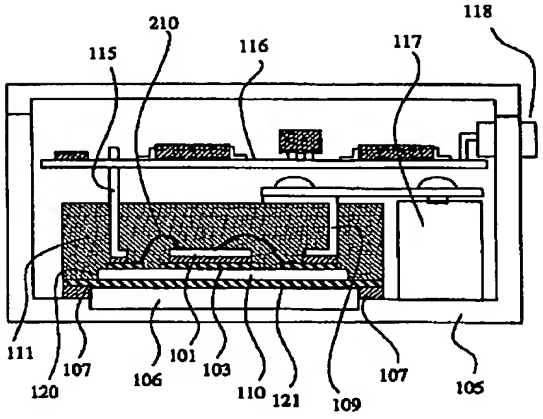
＊凹凸、１４２，１４４…裏面薄膜金属板曲部、１４３，１４５…裏面薄膜金属板とケースの接続部、１４６…ヒートパイプの熱媒体経路、１４７…ボルト、１４８…裏面薄膜金属板はみ出部、１５３…蓋、１５５，１６２…ケース接合部、１８２，２０２，２０４…リード端子、１８３…モールド材、１９１，１９２，１９３…端子接続部、１９５，３０３…フリーホイールダイオード、１９６…フィン、２０１…リード端子接合部、２０３…リード端子接合部境界、２１０…アルミワイヤ、３０１…１相分パワー回路、３０４…Ｐ側配線、３０５…Ｎ側配線、３０６…負荷配線、８０２，８０５…接合材、８０３，８０６，８０７…金属板、８０４…はみ出部。

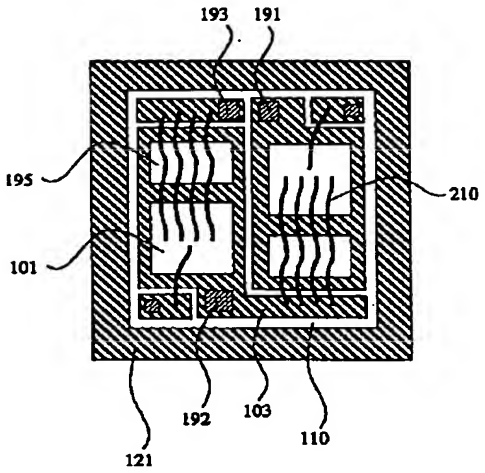
【図１】

図 1



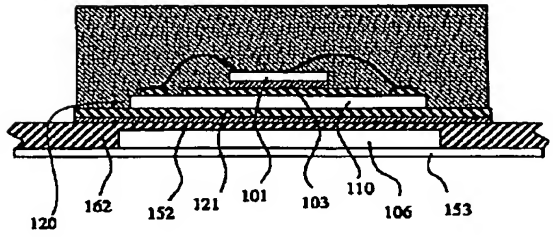
【図２】

図 2



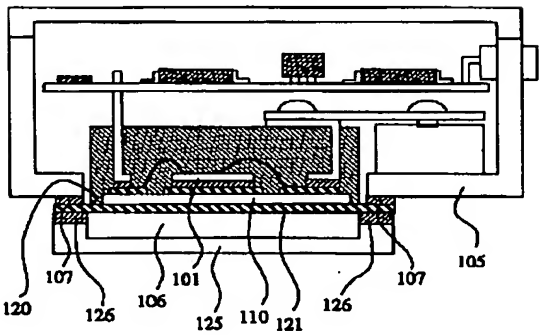
【図７】

図 7



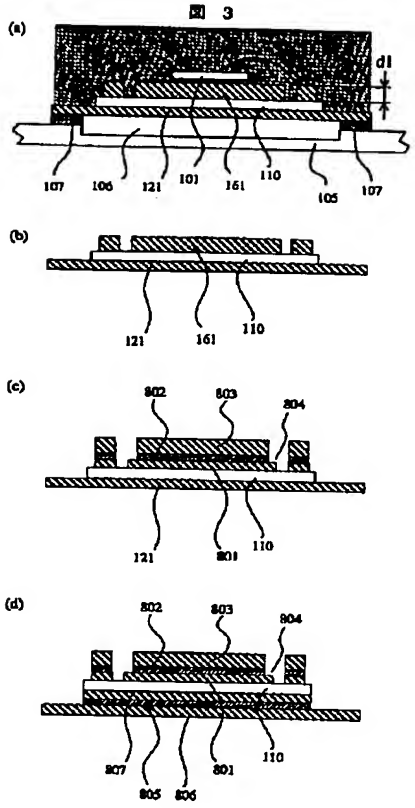
【図９】

図 9



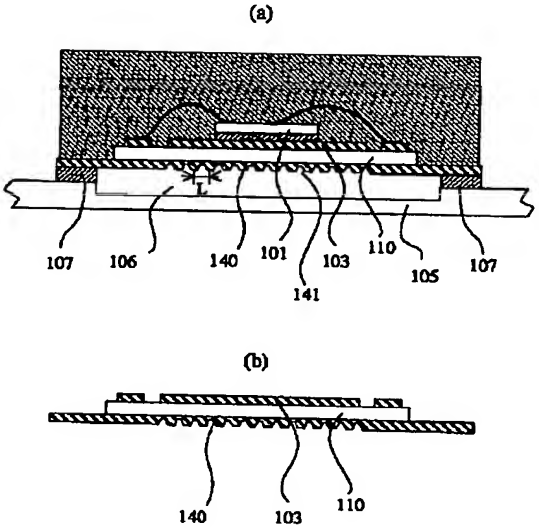
【図３】

図 3



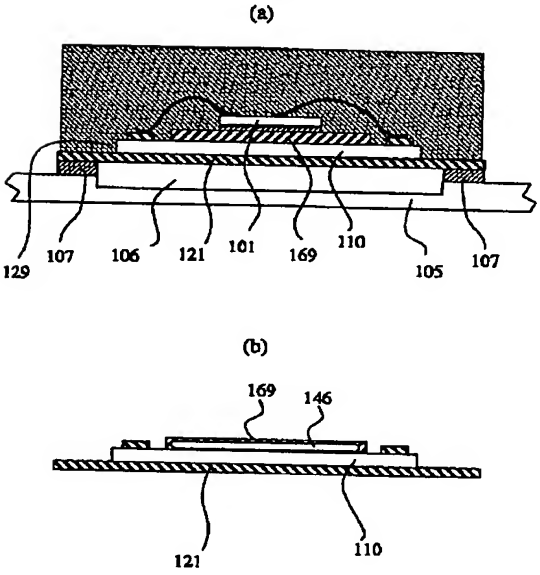
【図４】

図 4



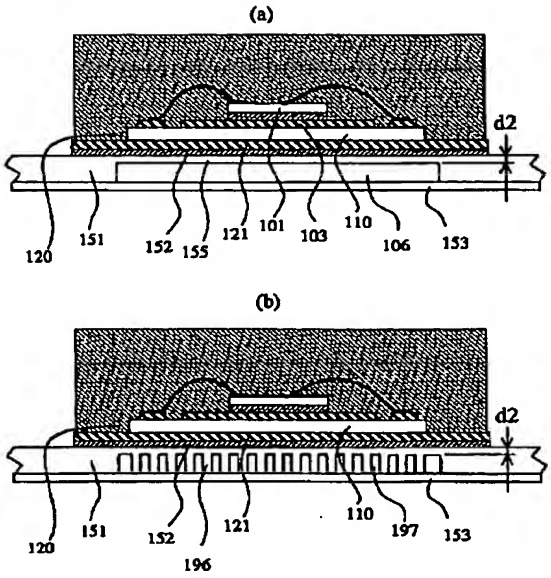
【図５】

図 5



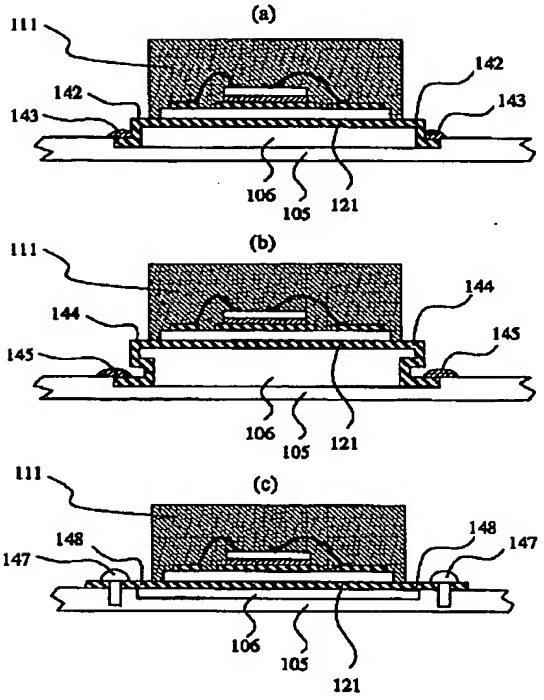
【図６】

図 6



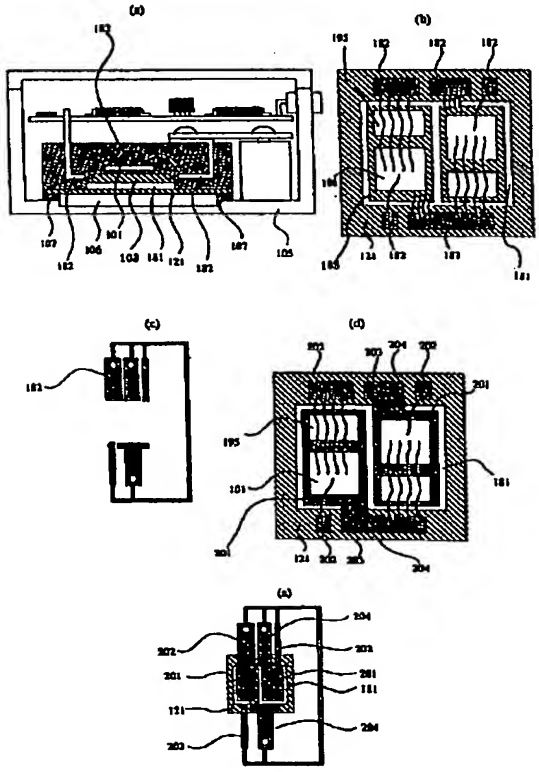
【図８】

図 8



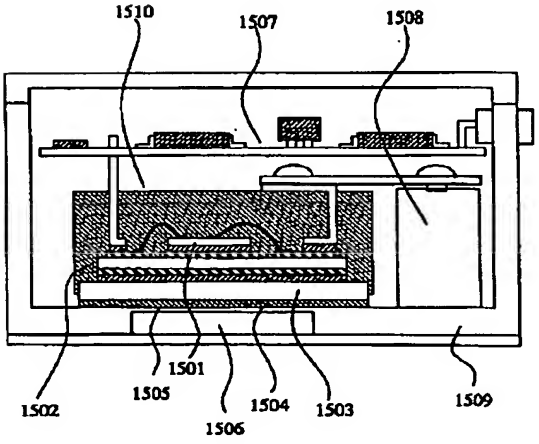
【図１０】

図 10



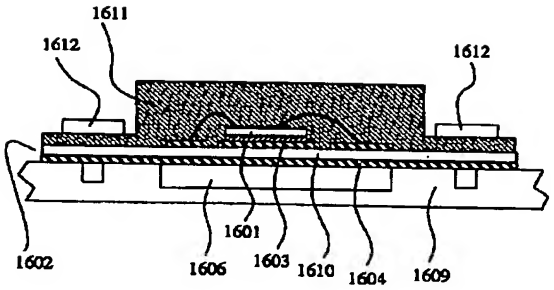
【図１１】

図 11



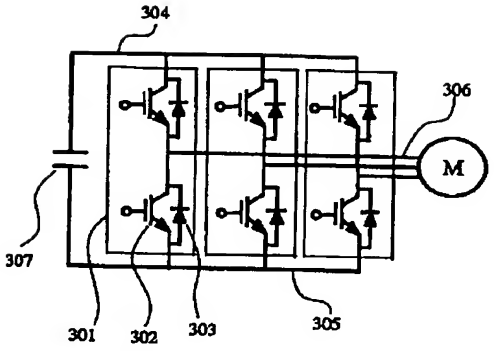
【図１２】

図 12



【図１３】

図 13



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